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Technology Opportunity

Technology Transfer & Partnership Office

TOP3-00160

Oil-Free Turbomachinery Technologies Creating a Revolution in Aircraft Propulsion

Technology

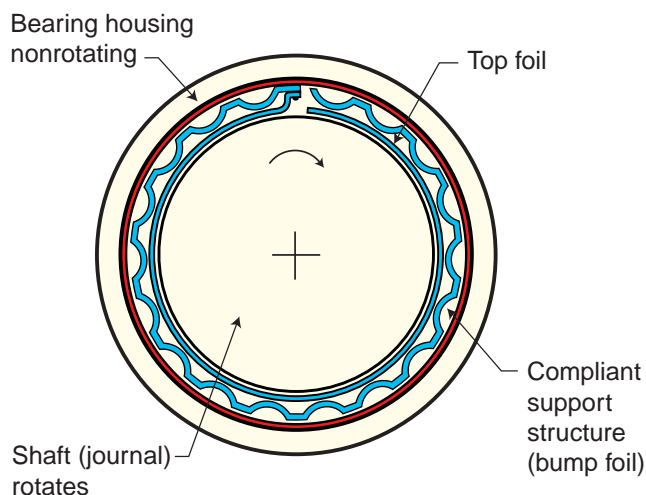
NASA Glenn's Oil-Free turbomachinery research team is helping to develop three key technologies: foil air bearings, high-temperature solid lubricants, and computer-based modeling. Recent breakthroughs in these key technologies now enable the demonstration of revolutionary Oil-Free gas turbines.

Benefits

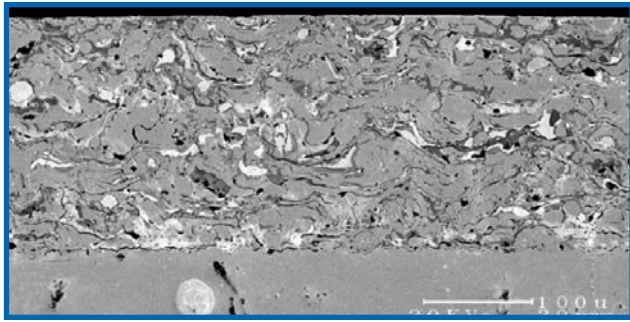
- Oil-Free technology eliminates turbine engine oil system resulting in 15 percent weight savings
- Long wear life PS300 shaft coatings provide a maintenance-free bearing system, reducing engine maintenance costs by 50 percent
- Elimination of ball bearing imposed shaft speed (DN) limits allows engines to run faster producing more power (>20 percent power density increase)
- NASA patented PS300 coatings have enabled bearing operation to temperatures over 650 °C, reducing or eliminating the need for coolers and bleed air
- Oil-Free engines enable 50 passenger regional jets to achieve 8 percent cost reduction (DOC)

Commercial Applications

- Oil-Free turbomachinery technology (foil bearings, coatings, modeling) has been commercialized in aircraft air cycle machines (ACMs) for cabin pressurization and cooling, in cryogenic turbocompressors, and in microturbine electrical generators (<100 kW).



- Emerging applications include Oil-Free turbochargers, larger turbine generators, General Aviation (GA), BizJet, unmanned aerial vehicles (UAVs), and missile engines.
- Future applications are anticipated in auxiliary power units (APUs), regional jet and helicopter engines, revolutionary aeropropulsion engines, space power systems, and launch vehicle cryogenic turbomachinery.
- PS300 solid-lubricant technology has direct applications to any high-temperature sliding contact. Examples successfully fielded include steam turbine control valves, oven conveyor bushings and slide plates, automotive exhaust gas recirculation (EGR) valves, and aircraft bleed air valves. PS300 is available as a thermal spray coating or free-standing powder metallurgy (PM300) product.



Cross section of PS304 coating.

Technology Description

Oil-Free foil air bearings are self-acting hydrodynamic bearings that use ambient air as their working fluid. During operation, the bearings develop a lubricating air film which separates the shaft from the thin sheet metal foils that make up the bearing. This design requires no external pressurization. Since air cannot burn like oil, foil air bearings can operate at high temperatures. Foil bearings can operate at high speeds (no bearing DN limit) and tolerate misalignment and distortion. PS300, a solid lubricant made from a unique combination of metals, ceramics, and solid lubricant additives, is applied to the bearing shaft and reduces friction and wear during startup and shutdown when rubbing occurs prior to the development of a lubricating air film in the bearings. PS300 has successfully lubricated foil air bearings from 25 to 650 °C for over 100,000 start/stop cycles. Lastly, computer-based foil bearing and system integration modeling technologies allow the prediction of bearing performance and system stability without having to conduct extensive experimental studies. Oil-Free turbomachinery technologies enable the elimination of ball and roller bearings, filters, sensors, and plumbing associated with traditional oil-lubricated rotating systems.

Options for Commercialization

Industry sources for foil air bearings exist and are capable of engineering this technology into rotating hardware. NASA holds a patent (#5866518) on the PS300 solid lubricant and has awarded non-exclusive licenses for raw materials production,

powder metallurgy processing, and thermal spray coating desposition. Additional nonexclusive licensees are sought. Technical assistance for technology application is available from NASA technical and commercialization staff.

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References

LEW 16183-1, NASA/TM-1999-209187,
 NASA/TM-107332, NASA/TM-2000-209782
 U.S. Patent 5866518

Key Words

Oil-Free Turbomachinery
 Solid lubricants
 Coatings